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REPORT
PRELIMINARY HYDROGEOLOGIC ASSESSMENT OF
LIQUID WASTE DISPOSAL SITES IN THE VICINITY OF
COLUMBUS, BARTHOLOMEW COUNTY, INDIANA

FOR CUMMINS ENGINE COMPANY, INC.

FEBRUARY 5, 1985
JOB NO. 12618-001-17

Dames & Moore

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2.1.2 **Ceraland Site**

The Ceraland site is situated in the upland region to the east of the East Fork of the White River, and lies at an elevation of [redacted] feet. Topography within the site is generally rolling with mild slopes, between [redacted]. In the south-central portion of the site, slopes approach 18 degrees on the sides of a valley occupied by an intermittent stream.

Surficial soils within the site belong to the Fincastle-Brookston and Miami-Fincastle-Hennepin Associations (Brownfield, 1976). These soils are well to very poorly drained, medium to moderately fine textured, with the better-drained soil occurring on the steeper slopes. Permeability of the surficial soils vary from 0.1 to 3 ft/d (Brownfield, 1976).

The geologic description of the Ceraland Park was based on descriptive geologic logs reported by water well drillers (Table 3), description of soils, and several shallow soil borings.

Most of the site is blanketed by glacial till (Figure 4) to depths approaching 50 feet. Portions of the till are covered by 1 to 3 feet of loess, a windblown, fine-textured sediment; several of the soil types found at Ceraland are derived from loess (Brownfield, 1976).

Several shallow boreholes were drilled on the Ceraland site in conjunction with foundation studies for a water tower (Soil Engineering Services, 1967) and a building (ATEC Associates, Inc., 1979). The till is generally described as mottled brown and gray silty clay with traces of sand and gravel. Consistency of the till ranges from stiff to very hard, and its natural water content varies between 15 and 25 percent.

The uppermost till unit is believed to be part of the Trafalgar Formation, associated with the Wisconsinan Glacial Stage. Till of the Jessup Formation, an earlier deposit associated with the Kansan to Sangamonian Stages, may underlie the Trafalgar till. Tills of both formations are highly calcareous where they have not been extensively leached.

The New Albany Shale, described in the previous section, probably underlies most of the Ceraland site. The shale is on the order of 10 to 30 feet thick over the southern two-thirds of the site and appears to be thin or absent toward the north (Figure 4). The North Vernon and Jeffersonville Limestones are encountered beneath the shale.

2.2.2 **Ceraland**

The Ceraland site is in an upland area between Little Sand Creek and Fishers Fork with all but the northernmost edge of the site draining towards Little Sand Creek. Little Sand Creek flows toward the southwest and eventually drains into the East Fork of the White River. An intermittent stream runs through the center of Ceraland. This stream was dammed at least 30 years ago to form a lake with a surface area of

Data concerning the ground water flow system at Ceraland are very limited. Observation wells (details of completion not known) were installed in two test borings drilled for the recreation center in the southwest corner of the site (ATEC Associates, 1979). After 6 days the observed water levels were between 2[redacted]face. These observations probably indic[redacted].

The most probable ground water flow system based on the local geology is split into two components--a shallow, perched system and a deeper, regional system. The flow system perched on the New Albany Shale probably flows toward the lake and intermittent stream valley within Ceraland and towards Little Sand Creek to the south of Ceraland. A small portion of the water probably is lost by vertical leakage downward through the New Albany Shale. The deeper flow system, in the underlying limestone strata, appears to flow to the southwest. The potentiometric surface for this system, shown in Figure 6, is based on the static water levels reported by drillers during well drilling operations. The water levels were measured over a 7-year period and represent wells cased to varying depths, so the hydraulic head values can only approximate the potentiometric surface. In addition, the hydraulic head measured by well 5 (see Figure 4) is about 20 feet below those measured in wells 3 and 6. Since the casing of well 5 also extends about 25 feet deeper into the aquifer, the head difference may be indicative of a downward flow component within the limestone. If the shale and till have similar permeabilities, there would be a continuous flow system from the shallow water table to the regional limestone aquifer. The dominant ground water flow direction in the till and shale in this case would be vertically downward.

The hydraulic conductivity of glacial till and shale can vary over many orders of magnitude depending on the grain size distribution of the material, degree of induration, and extent of fracturing. In unfractured units the hydraulic conductivity can be as low as 10^{-8} ft/d, while highly fractured zones may have hydraulic conductivity values as high as 0.1

ft/d (R. A. Freeze and J. A. Cherry, 1979). Glacial till typically has a porosity of about 0.30, while shale has an effective porosity generally less than 0.10 (D. A. Morris and A. L. Johnson, 1967).

The degree of fracturing, hydraulic conductivity values, porosity values, and hydraulic gradients for the shale and glacial till beneath the Ceraland Park are not known. Estimates of ground water seepage velocities must therefore be based on values typically found in similar hydrogeologic settings. Hydraulic gradients typically fall in the range of 0.5 to 0.0005 ft/ft, with 0.5 ft/ft being representative of high vertical gradients and 0.0005 ft/ft being representative of low horizontal gradients. Combining these values of hydraulic gradients with the ranges of hydraulic conductivity and porosity values presented in the previous paragraph, seepage velocities of fractions of a foot in thousands of years to several tenths of a foot in a day, can be derived.

The permeability of limestone can also vary many orders of magnitude, depending on the degree of fracturing and the amount of limestone dissolution. There are no data available on the hydraulic properties of the limestone beneath the site; therefore, seepage velocities can again be only estimated. Many of the local water supply wells require from 10 to 60 feet of uncased limestone to supply individual home water systems. These long boreholes indicate the limestone to have a moderate to low permeability. The hydraulic conductivity of a moderately permeable limestone is on the order of 0.02 ft/day (R. A. Freeze and J. A. Cherry, 1979), while the effective porosity is probably about 0.30 (D. A. Morris and A. L. Johnson, 1967). Under a hydraulic gradient of 0.004 (from Figure 6), the ground water flow velocity would be approximately 0.1 ft/yr.

Water samples from the two wells at Ceraland were collected by Dames & Moore personnel on January 28, 1982. Both wells were allowed to pump for approximately 15 minutes at a rate of about 50 gallons per minute (gpm), before water samples were collected. The unfiltered water samples were sent without chemical preservatives to Howard Laboratories of Dayton, Ohio for analysis, the results of which are listed in Table 4. The water in the limestone aquifer is very hard with a slightly basic pH of 7.3 to 7.6 (Table 4). Iron concentrations were very high, 5.158 and 5.960 mg/L, such that the clear, colorless water samples turned brown and cloudy within hours after collection as the iron precipitated in the form of ferric hydroxides, even under refrigerated conditions.

An organic scan of the two Ceraland Park samples found no halogenated organic compounds above a background limit of 0.002 mg/L. Non-halogenated organic compound(s) were detected by gas chromatography, but the concentration of the substance(s) was too low to allow identification by mass spectrophotometry.

The U.S. EPA has established two sets of water quality standards for drinking water. The first set, the Primary Drinking Water Standards (PDWS), establish maximum permissible concentrations for constituents considered to have significant adverse effects on human health. Secondary Drinking Water Standards (SDWS) have been set for a second group of constituents which do not pose a direct hazard to human health but may limit the suitability of that water as a drinking water supply.

The limestone aquifer, tapped by the Ceraland Park wells, supplies water with iron concentrations 15 to 20 times greater than the recommended limit of 0.3 mg/L.

2.4.2 **Ceraland**

Records obtained from the Division of Water, Indiana Department of Natural Resources, indicate that there are at least 10 private wells in the vicinity of Ceraland Park (Figure 2, Table 3). These records are not complete, and it is likely that there are perhaps twice that many wells supplying water to rural homes in the area. Well completion records indicate that individual wells are cased through the glacial till and the shale. Water intake zones consist of 10 to 60 feet of uncased borehole within the limestone section.

During the middle 1970s, rural water supply systems began to expand service into the vicinity of Ceraland. It is not known how many residences have been connected to the system, although it is suspected that most residences have because of the poor quality of ground water available from the limestone aquifer.

From 1965 to 1975 the Ceraland Park obtained its water supply from one or both of two wells (C1 and C2, Table 3). The wells are cased through the glacial till and shale, and draw ground water from a section of limestone strata, about 90 feet thick. Both wells produce ground water at a rate of about 50 gpm each (R. White, Ceraland manager, personal communication). By 1975 Ceraland was connected to the rural water supply system, and the wells are now used only during peak summer demand periods. Regular use of these wells is generally avoided because of the poor quality water they produce.

3.1.6 Ceraland, Site No. 5

Ceraland is located about 2 miles south and 6 miles east of Columbus. The 350-acre site is owned and operated by the Cummins Engine Company, Inc. as a recreational facility for company employees. In 1958, oily wastes began to be used for dust suppression on the main roads and parking areas within the park (Figure 2). By 1968, 4,080,000 gallons of waste oils had been spread on road surfaces and parking lots according to Cummins Engine. In the middle 1970s, the oiled gravel roads were paved with asphalt. Before the asphalt was applied, the previously oiled surface was scarified, graded, and covered with several inches of gravel. No oily dirt was removed from the roadways.

4.3 CERALAND, SITE NO. 5

The potential for ground water contamination at Ceraland is very small because the waste liquids were spread on materials of very low permeability well above the water table. Infiltration through the oil-covered soils was reduced further by the compaction resulting from vehicular traffic on the oiled roadways and parking areas. The movement of soluble components of the oily wastes was probably reduced even further in the middle 1970s when all roads and parking lots were paved.

Any dissolved wastes that reach the water table will continue to move very slowly. The worst situation would occur if ground water flow is directed vertically downward to the limestone aquifer, where the Ceraland Park wells obtain their water. The drillers' logs for the Ceraland wells (C1 and C2, Figure 4) indicate the till and shale layers each to be about 10 feet thick. If this entire thickness is fractured, saturated with water, and there is no diffusion of pollutants from the fracture into unfractured blocks of till and shale, it would take less than 1 year for affected water to reach the limestone. Although fractures in glacial till can extend to depths of several tens of feet, the number and hydraulic conductivity of these fractures normally decrease with depth as lateral stresses squeeze the fractures closed (R. A. Freeze and J. A. Cherry, 1979).

A second more probable scenario can therefore be derived in which fractures effectively increase the hydraulic conductivity of the material overlying the limestone aquifer only to a depth of about 10 feet. The presence of this more likely situation increases the estimated travel time to the limestone aquifer to hundreds of thousands of years. In this case, the low permeability of the unfractured lower 10 feet of till or shale would cause infiltration water (and any dissolved waste materials) to preferentially flow horizontally at rates on the order of a few feet each year. The shallow, horizontal flow system would eventually discharge into the lake or intermittent stream within Ceraland Park or the Little Sand Creek.

In the unlikely case that dissolved waste materials reach the limestone aquifer, the only wells that might seriously be affected are the two wells within Ceraland. Even with this scenario, seepage through the shale would result in dilution within the limestone aquifer.

Waste oils previously used for dust control at Ceraland from the period 1958 to 1968 pose a very low risk to water supplies, because the nearest aquifer is separated from the wastes by several tens of feet of low permeability glacial till and shale. Water infiltration through the oils has also been reduced to near zero by the asphalt pavement that now covers all the previously oiled roadways and parking areas.

TABLE 3

WELL COMPLETION DATA REPORTED TO THE
INDIANA DEPARTMENT OF NATURAL RESOURCES,
DIVISION OF WATER,
FOR WATER WELLS DRILLED IN AND
AROUND CERALAND PARK

Well No.	Completion Date	Depth Drilled (feet)	Depth of Casing (feet)	Approximate Ground Elevation (feet above msl)	Approximate Elevation of Water in Well
1	06-1963	130	44	670	?
2	02-1965	106	35	672	640
3	03-1966	102	42	664	624
4	10-1967	71	62	640	?
5	10-1962	74	40	635	599
6	08-1961	120	?	650	619
7	01-1969	126	?	650	612
8	09-1960	48	37	652	624
C1	04-1965	?	27	650	612
C2	1964	120	120	650	608

TABLE 4

CHEMICAL ANALYSES OF SELECTED GROUND WATER
SOURCES IN THE VICINITY OF
COLUMBUS, BARTHOLOMEW COUNTY, INDIANA

	Ceraland Park	
	Well C1	Well C2
Sampling date	01-1982	01-1982
pH (units)	7.3	7.6
Specific electrical conductance (umhos/cm)	760	740
Total dissolved solids	464	469
Hardness (as $CaCO_3$)	437	410
Alkalinity (as $CaCO_3$)	-	-
Calcium	-	-
Magnesium	-	-
Sodium	-	-
Sulfate	-	-
Chloride	10	10
Nitrate (as N)	-	-
Iron	5.158	5.960
Manganese	-	-
Analyst	Howard Lab.	Howard Lab.

Note: All parameters expressed in milligrams per liter, unless otherwise noted.

[1] State Board of Health.

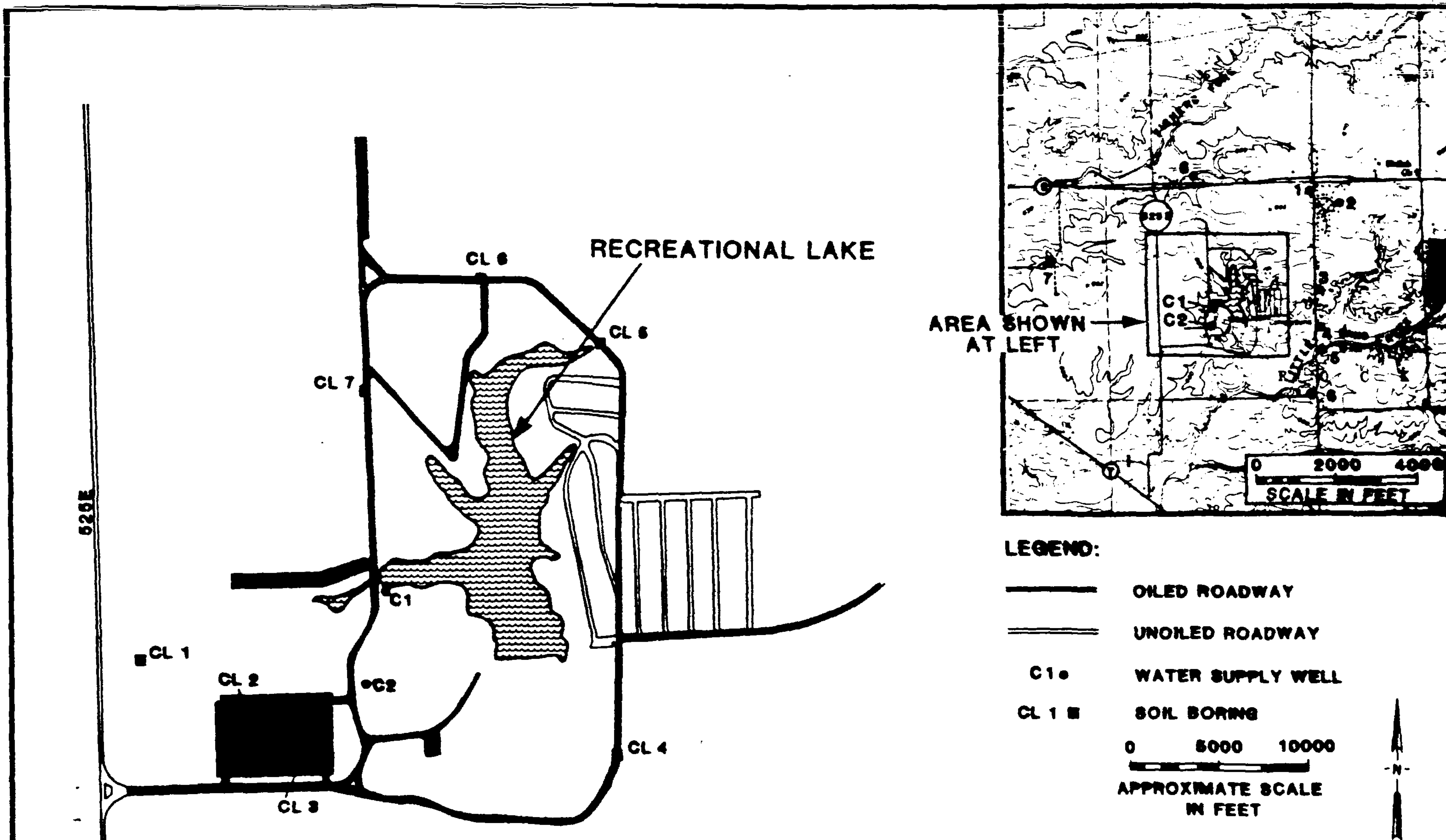

FIGURE 2

CERALAND PARK
(WASTE DISPOSAL SITE NO. 5)

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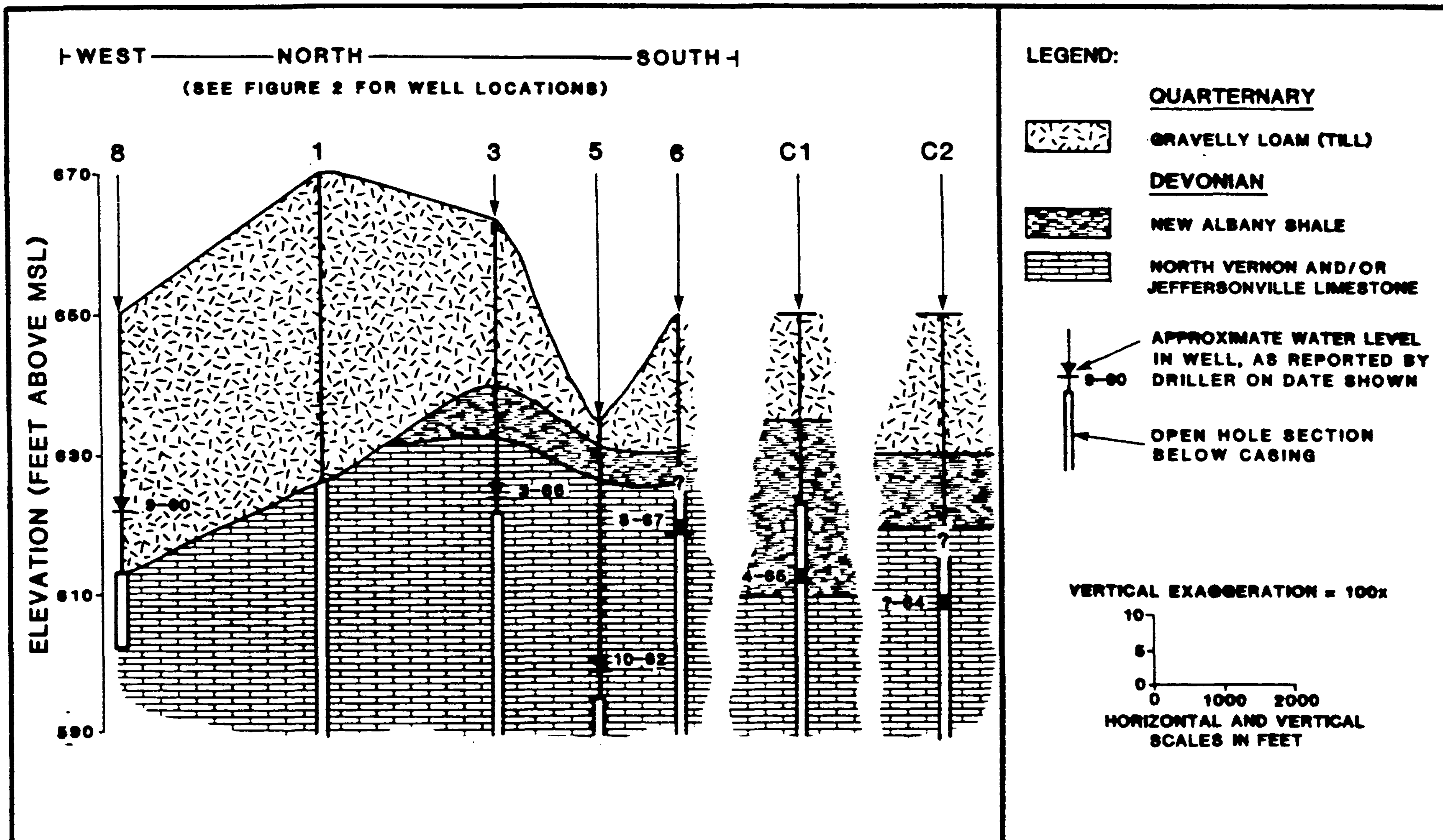

FIGURE 4

CROSS-SECTION THROUGH THE CERALAND PARK SITE

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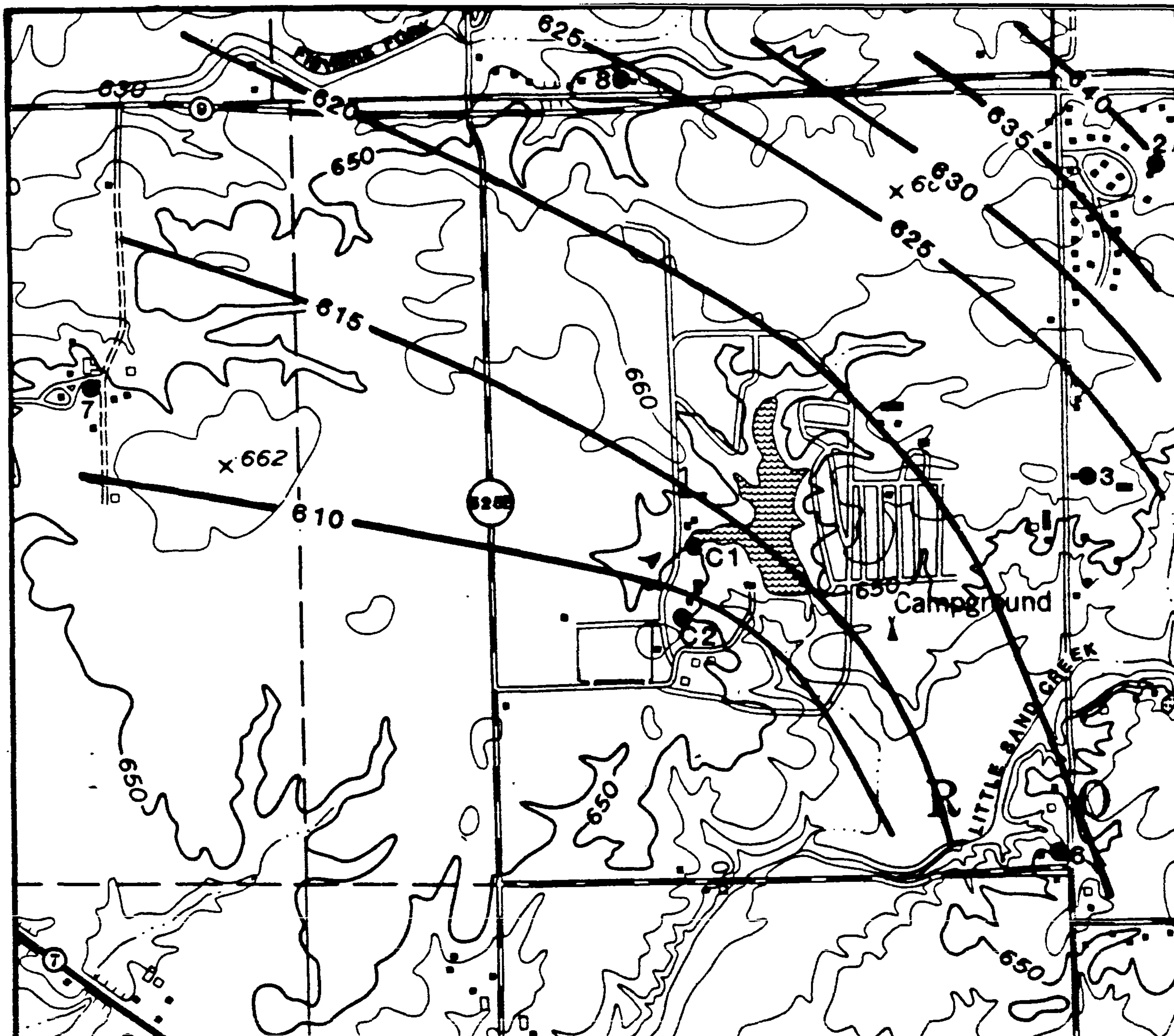

LEGEND:

● 8 WATER SUPPLY WELL (TABLE 3)

—610 APPROXIMATE PIEZOMETRIC CONTOUR (INTERPRETATION BY DAMES & MOORE)

N

0 500 1000

SCALE IN FEET

FIGURE 6

POTENTIOMETRIC SURFACE WITHIN THE LIMESTONE AQUIFER BENEATH THE CERALAND SITE

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